REMARKS

Reconsideration of the application is respectfully requested for the following reasons:

1. Objection to Disclosure Under 35 USC §112, 1st Paragraph

This objection has been addressed by revising the specification, title, and abstract to place them in proper U.S. format and to correct various grammatical and idiomatic errors, including those noted in item 2a on page 2 of the Official Action.

Because the changes are all formal in nature, it is respectfully submitted that the changes do not involve new matter.

2. Objection to Drawings

This objection has been addressed by amending Figs. 1-4 to include the label –(Prior Art)–, as required in item 3 on page 2 of the Official Action.

3. Rejections of Claims Under 35 USC §112, 1st and 2nd Paragraphs, and Claim Objections

The claim objections and rejection under 35 USC §112, 1st and 2nd Paragraphs, have been addressed by:

a. Amending each of the claims to correct grammatical and idiomatic errors as required in item 4 on page 3 of the Official Action;

b. Amending claims 2-6 to be in proper dependent format as required in item 5 on page 3 of the Official Action;

c. Amending claims 1-6 to track the language used in the original specification and to clarify some of the terminology (such as substitution of "retrieving" for "accessing"), as required in item 7 on pages 3-4 of the Official Action. However, it is respectfully noted that claims 1-6 are directed to a "method" and that it is not necessary to specify particular apparatus or "means" for carrying out the method steps. For example, the term "input" is well-understood by those skilled in the

art and it believed that a recitation that the gap-voltage deviation and cutting speed data used to construction the discharge-servo curves in order to set up the database is input via a CNC control panel, as disclosed in lines 1-5 on page 5 of the specification is neither necessary nor appropriate;

d. Amending claim 7 to recite connections between the various units, as required in item 8 on page 4 of the Official Action; and

e. Amending claims 1-6 to clarify the ambiguities and correct the antecedence errors noted in items 10-12 on pages 4-6 of the Official Action.

In view of the above-listed amendments to the claims, it is respectfully submitted that claims 1-6 are now in compliance with 35 USC §112, 1st and 2nd Paragraphs, and therefore withdrawal of the objection to the claims and rejections under 35 USC §112 is respectfully requested.

4. Rejection of Claims 1-7 Under 35 USC §102(b) in view of U.S. Patent No. 4,365,300 (Johanson)

This rejection is respectfully traversed on the grounds that the Johanson patent neither discloses nor suggests a method device for controlling an electrical discharge machine in which multiple, **pre-stored**, discharge servo curves may be **retrieved and swapped** in real-time **during a cutting procedure**, and therefore ***account for changes that might occur in the cutting conditions***, such as changes in the material of the workpiece. In fact, while the Johanson patent discloses a cutting machine servo control, the servo control does **not** rely on pre-stored discharge curves at all, but rather provides a means for an operator a specific set of parameters for a particular cutting operation.

According to the invention, the operator pre-stores multiple sets of parameters for control of the cutting process. The parameters include gap-voltage deviation and cutting speed, which in turn depend on parameters such as ON-TIME, OFF-TIME, current reference gap voltage, and so forth, and which are combined to construct discharge servo curves for controlling the cutting

apparatus during a cutting operation. Each set of conditions (workpiece material, electrode material, cutting solution, and so forth) requires different gap to voltage deviations and cutting speeds, and therefore the target gaps and cutting speeds that the servo attempts to achieve must be varied as conditions change. According to the invention, this is accomplished by adding a "discharge-servo curve instruction" to the control program, and pausing the operation so that the operator can choose a different discharge-servo curve when cutting conditions change. The discharge-servo curves are constructed by performing test runs under different conditions and obtaining a set of gap-voltage deviations and cutting speeds for the test runs.

The method disclosed by Johanson, in contrast, does not pre-store multiple curves or sets of cutting control parameters. Instead, Johanson merely enables the necessary parameters to be more easily entered by the operator and displayed for verification. This is no different than the procedure illustrated in Fig. 4, in which when a servo curve is to be changed, the control program must go back to the discharge-servo curve definition step, and is to be contrasted with the procedure illustrated in Fig. 5 and present claimed, in which the program checks for a discharge-servo change instruction and, if such an instruction is detected, retrieves an appropriate pre-stored curve from a database and immediately continues the cutting procedure using the new curve.

It is true that Johanson mentions, in col. 5, lines 1-7, switching to canned programs for a square, circle, or triangle. However, these canned programs merely provide directional data, and do not correspond to the claimed curves constructed from gap-deviation and cutting speed data corresponding to different cutting conditions. In order to use the "canned" programs of Johanson under different cutting conditions, the operator must still pause the cutting procedure and input a new set of gap-voltage deviations and cutting speeds.

Because the Johanson patent fails to disclose a control method or device that enables servo control parameters, *i.e.*, the discharge-servo curves, to be changed during a cutting procedure to account for changes in workpiece material, and the like, it is respectfully submitted

that the Johanson patent does not anticipate any of claims 1-7, and withdrawal of the rejection of claims 1-7 under 35 USC §102(b) is respectfully requested.

Having thus overcome each of the objections and rejections made in the Official Action, withdrawal of the rejections and expedited passage of the application to issue is requested.

Respectfully submitted,

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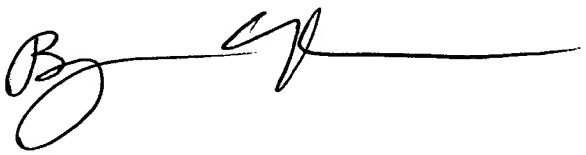

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~~THE MULTIPLE DISCHARGE~~-SERVO CURVE CONTROL METHOD AND DEVICE ~~OF~~ FOR AN ELECTRICAL DISCHARGE MACHINE

[0001] BACKGROUND OF INVENTION

[0002] Field of Invention

[0003] This invention ~~mainly develops the~~ relates to a ~~multiple discharge servo curve~~ control method and device ~~of~~ for an electrical discharge machine capable of employing multiple discharge-servo curves~~. Especially, it means~~, and especially to a numerical control method used by the electrical discharge machine~~, herein it will~~ to choose multiple ~~discharge~~ servo curves by calling ~~the~~a ~~discharge~~ servo curve instruction during the machining process. This application can be used for ~~the~~any electrical discharge machine, ~~the~~ including a drilling electrical discharge machine, and ~~the~~ a wire-cut electrical discharge machine.

[0004] Description of The Prior Art

[0005] An Electrical Discharge Machine (EDM) ~~adopts~~utilizes the sparking generated between the electrode and workpiece~~, and then melts~~ to melt as well as ~~evaporates the~~ evaporate material, under a locally instant high temperature condition, to achieve the cutting result, which is a non-traditional machining technology. ~~Since~~ Even though EDM has already been adopted to ~~treat~~ cut a more complex and higher precision product by ~~the~~ industries worldwide, ~~but~~ the precision control technique of EDM is still not good enough and needs to be improved ~~indeed.~~

[0006] The gap-voltage control-loop of the electrical discharge machine ~~will determine~~determines the suitable cutting speed by ~~the~~ real-time measurement of the ~~moving and the calculating the~~ movement and calculation of the deviation of the gap-voltage. ~~Moreover,~~ Figure 1 ~~shows the~~ is a functional block diagram of a known gap-voltage control loop of the electrical discharge machine, ~~wherein it will~~ which is arranged to calculate the gap-voltage difference between the real measurement and the operator inputs, and then ~~outputs~~to output the cutting speed after the outcomes are processed through the ~~multiple discharge~~ servo curve controller and the deviation controller. Furthermore, the positioning control-loop guides the electrical discharge machine to work on the cutting ~~with~~ according to a position command integrated by the integrator. Finally, ~~it will issue~~the positioning control-loop issues a real gap dimension for calculating the gap deviation by subtracting ~~that~~ the real gap dimension ~~with~~from an original operator-input gap value, ~~and~~ calculates the gap-voltage ~~by~~ according to the gap ~~and~~deviation using the gap-voltage converter, and then subtracts that gap-voltage ~~with the referred~~from the reference operator-input gap-voltage. ~~Recursively, the~~ The next gap-voltage control cycle ~~goes on, wherein~~ is then carried out in an iterative manner, the cutting speed ~~corresponded~~again corresponding to the gap-voltage deviation, which is calculated by the internally used gap-voltage deviation and cutting speed control curve of the ~~multiple discharge~~ servo curve controller. The combined gap-voltage deviation and ~~the~~ cutting speed control curve are generally ~~called~~ referred-to as a discharge-servo curve. As shown in the Figure 2, the discharge-servo curve is built on the relationship of the gap-voltage deviation and the cutting speed, and contains a nonlinear discharge-servo curve la and a linear discharge-servo curve lb.

[0007] The ~~multiple discharge~~ servo curve controller of the electrical discharge machine chooses a discharge-servo curve by the control software device of a known electrical discharge machine software structure, as shown in Figure 3~~, and then that~~. A flowchart of a known discharge-servo curve control method is shown in Figure 4. Before ~~initiate~~initiating the program, the discharge-servo curve is set ~~on~~ via the CNC control panel and the discharge-servo curve data is recorded ~~insider~~within the ~~multiple discharge~~ servo curve controller, and then a cutting process ~~goes on following with~~ is carried-out according to the discharge-servo curve data which is recorded ~~insider~~within the ~~multiple discharge~~ servo curve controller as soon as the program is started.

[0008] The required cutting speed ~~is different~~differs during the workpiece cutting process, ~~which dues to the~~ as a result of different machining ~~environment~~environments resulting from factors such as a different material of electrode, workpiece, cutting solution, and coarse or fine process. If the known discharge-servo curve control method is adopted, the executing program has to be stopped in order to exchange ~~a~~ discharge-servo curve data, and ~~then backs to set~~ returned to the step of setting the discharge-servo curve on the CNC control panel for swapping the record ~~insider~~ within the ~~multiple discharge~~ servo curve controller and the discharge-servo curve data. Therefore, it is really not convenient to the case of a single workpiece with ~~multiple discharge~~ servo curves. ~~Conclusively, how~~ How to allow an electrical discharge machine arbitrarily ~~choosing~~ to choose the discharge-servo curve during the real cutting process is ~~sincerely~~ a significant problem.

[0009] **SUMMARY OF THE INVENTION**

[0010] The main purpose of this invention ~~can lead~~ is to solve the aforesaid defects. ~~Adopt the program calling, this invented~~ by providing a ~~multiple discharge~~ servo curve control method and device ~~of~~ for an electrical discharge machine ~~will allow~~ that allows the operator to swap ~~the~~ different discharge servo ~~curve~~ curves in ~~according~~ accordance with the ~~real~~ actual process ~~requirement~~ requirements during operation of the electrical discharge machine ~~working~~, and by further to ~~achieve the~~ providing a one-step process ~~with~~ for arbitrarily choosing the ~~multiple discharge~~ servo ~~curve~~ curves.

[0011] **BRIEF DESCRIPTION OF THE DRAWINGS**

[0012] FIG. 1 is a functional block diagram of a known gap-voltage control loop ~~of the~~ for an electrical discharge machine.

[0013] FIG. 2 is a plot of the discharge-servo curve.

[0014] FIG. 3 ~~is~~ illustrates a configuration of a known electrical discharge machine software structure.

[0015] FIG. 4 is a flowchart of a known discharge-servo curve control method.

[0016] FIG. 5 is a flowchart of ~~this invented~~ a preferred ~~multiple discharge~~ servo curve control method ~~of~~ for an electrical discharge machine.

[0017] FIG. 6 is ~~a hierarchy~~ a block diagram of ~~this invented~~ the preferred control software structure.

[0018] FIG. 7 ~~is~~ illustrates a configuration of ~~this invented~~ a preferred ~~multiple discharge~~ servo curve control device ~~of~~ for an electrical discharge machine.

[0019] **DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS**

[0020] ~~This~~ The invention is ~~the~~ a ~~multiple discharge~~ servo curve control method and device ~~of~~ for electrical discharge machine~~; the~~. A flowchart of ~~this invented~~ a preferred embodiment of the ~~multiple discharge~~ servo curve control method is shown in Figure 5. ~~Primarily set~~ First, the discharge-servo curve database ~~11~~ is set in step 11 whenever the beginning ~~10~~ command is issued (step 10), wherein each gap-voltage deviation and its corresponded cutting speed of the discharge-servo curve are input from the CNC control panel in order to set up the ~~multiple discharge~~ servo curve database. The algorithm of the discharge-servo curve is constructed on the records of the gap-voltage deviation and the cutting speed ~~that is~~ measured under ~~the~~ real optimal processing ~~condition~~ conditions. Moreover, the discharge-curve is correlated ~~it~~ with the collected gap-voltage deviation and its cutting speed ~~that are under the~~ for different electrode ~~material~~ materials, different workpiece ~~material~~ materials, and different cutting ~~solution~~ solutions. A polynomial equation is expressed with those gap-voltage deviations and its corresponded cutting speeds as:

$$f(e) = ao + a1 \times e + a2 \times + e2 + a3 \times e3 + a4 \times e4 + A + an \times en$$

where f(e) is the cutting speed and e is gap-voltage deviation. The aforesaid polynomial equation is called ~~as~~ the discharge-servo curve equation, and it is used to set up the discharge-servo curve with lots of different processing conditions. Moreover, ~~defining~~ the discharge-servo curve parameter 12 is first set in the discharge-servo curve database to correspond to a numerical value of the discharge-servo curve parameter; such ~~as~~ that the 1st discharge-servo curve

corresponds to a numerical value of the discharge-servo curve parameter that is set as "1" in the discharge-servo curve database, and then ~~set that~~ the discharge-servo curve parameter's value is set to be that given by the appropriate discharge-servo curve, *i.e.*, ~~according to~~ the discharge-servo curve required ~~under process~~ for a particular processing environment. After all ~~read~~ the initial discharge-servo curve data 13 is read, ~~which is~~ based on the discharge-servo curve parameter's value, then ~~read its~~ it's the corresponded discharge-servo curve data from the discharge servo curve database are read and ~~record it~~ recorded into the ~~multiple discharge~~ servo curve controller. ~~Input the~~ The processing program ~~14~~ is input in step 14 after ~~set~~ setting and ~~read~~ reading the discharge-servo curve data for the machining required, ~~which is~~ by using the CNC control panel to key in ~~the~~ each working instruction and ~~the~~ discharge-servo curve instruction for processing program setup. Once the processing program ~~finished the editing~~ been edited, it ~~then starts the processing program~~ is started in step 15. ~~Beyond this moment, Program~~ Subsequently, a program node for judging the working instruction ~~16 will be~~ is used in step 16 to determine: when the program node is a working instruction and, ~~it executes~~ is so, the working instruction is executed in step 17, ~~which is~~ using the discharge-servo curve data of the internal record of the ~~multiple discharge~~ servo curve controller to execute the cutting process, or when the program node isn't a working instruction, ~~it will execute~~ the program node for judging the discharge-servo curve instruction is executed in step 18. Moreover, when the program node is the instruction for accessing the nth discharge-servo curve data (referred-to as "discharge machining NO.n"), ~~access~~ the discharge-servo curve data is accessed in step 19, ~~which~~ and the nth discharge-servo curve data ~~will be accessed~~ is retrieved from the discharge-servo curve database and ~~is then~~ stored ~~insider~~ within the ~~multiple discharge~~ servo curve controller, ~~, wherein the "discharge machining NO.n" is called as the discharge-servo curve instruction. Otherwise, it will finish the processing when~~ When the program

node isn't ~~the~~ a discharge-servo curve instruction, processing is finished. ~~Conclusively, the~~ The discharge-servo curve instruction of the processing program ~~presents~~ determines how to call the discharge-servo curve while the processing program is running. Therefore, this invention allow the operator to swap the different discharge-servo ~~curve~~ curves according ~~with the real process requirement~~ actual conditions that arise during the processing and to achieve ~~the~~ a one-step process ~~with~~ to arbitrarily ~~choosing~~ choose from among the ~~multiple discharge~~-servo ~~curve~~ curves.

[0021] During ~~the~~ processing, the software control device is designed to control the discharge-servo curve, as shown in Figure 6, ~~wherein this invented software control device comprises~~ by means of a human-machine interface unit 21, a ~~multiple discharge~~-servo curve control device 22, an operation unit 23, an interpolation unit 24, a machine logic-control unit 25 and a motion unit 26~~, which the multiple discharge-servo curve control device 22 of the software control device controls the discharge-servo curve~~.

[0022] As shown in Figure 7, ~~this invented~~ the preferred ~~multiple discharge~~-servo curve control device 22 ~~of~~ for electrical discharge machine~~, which comprises~~ includes a setting unit 221, a storage unit 222, a program unit 223, an instruction-judging unit 224 and a reading unit 225, wherein the storage unit 222 is used to store the discharge-servo curve data, and the setting unit 221 is used to set the parameter value of the discharge-servo curve. Referring to the parameter value of the discharge-servo curve that is kept in the setting unit 221, ~~read~~ the discharge-servo curve data from the storage unit 222 is read by accessing the storage unit through the reading unit 225. ~~As far as~~ When the reading process is over, ~~it will edit~~ the working instruction is edited and the discharge-servo curve instruction of the processing

program~~, then to start~~ starts the processing program~~. However~~, at which time the execution of the processing program ~~will been executing~~ is carried out in accordance with the discharge-servo curve data read from the reading unit 225. Whenever the processing program is started, the instruction-judging unit 224 will judge whether the program node is either a working instruction or a discharge-servo curve instruction. ~~Using the~~ when the program node is a discharge-servo curve instruction, which is edited by the program unit 223, ~~wherein it is called to swap the~~ different discharge servo curve data are swapped according ~~with the real process requirement~~ actual processing conditions during the processing program ~~executing and~~ execution to achieve ~~the~~ a one-step process ~~with~~ capable of arbitrarily choosing ~~the multiple discharge~~ servo ~~curve~~ curves. ~~All of the aforementioned are only parts of collected better cases; it can't be defined to restrict this invention's claims.~~ It will be appreciated that the above examples are exemplary in nature, and not intended to limit the invention, which are defined solely by the appended claims. ~~Furthermore, any~~ Any modification and/or adjustment of ~~this~~ the invention ~~scope are still belonged to this document~~ that may occur to those skilled in the art and that is within the scope of the claims should be included within the scope of the invention.